(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 670 614 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**24.06.2020 Bulletin 2020/26**

(21) Application number: **19214574.6**

(22) Date of filing: **09.12.2019**

(51) Int Cl.:
***C09D 5/08*** *(2006.01)* ***C09D 5/10*** *(2006.01)*
***C09D 7/61*** *(2018.01)* ***C09D 163/00*** *(2006.01)*
***C09D 1/02*** *(2006.01)* *C08K 3/08 (2006.01)*
*C08K 3/22 (2006.01)* *C08K 3/32 (2006.01)*
*C08K 3/34 (2006.01)* *C08K 5/098 (2006.01)*

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
**BA ME**
Designated Validation States:
**KH MA MD TN**

(30) Priority: **11.12.2018 US 201816216672**

(71) Applicant: **Hamilton Sundstrand Corporation**
**Charlotte, NC 28217-4578 (US)**

(72) Inventors:
- **ZHU, Tianli**
**Glastonbury, CT 06033 (US)**
- **SMITH, Blair A.**
**South Windsor, CT 06074 (US)**
- **ZHANG, Weilong**
**Glastonbury, CT 06033 (US)**
- **KRYZMAN, Michael A.**
**West Hartford, CT 06107 (US)**
- **ZAFIRIS, Georgios S.**
**Glastonbury, CT 06033 (US)**
- **VAN HASSEL, Bart Antonie**
**Weatogue, CT 06089 (US)**

(74) Representative: **Dehns**
**St. Bride's House**
**10 Salisbury Square**
**London EC4Y 8JD (GB)**

# (54) A CHROMIUM-FREE CORROSION INHIBITION COATING

(57) Disclosed is a corrosion inhibition coating, comprising: a base comprising a matrix and a metal within the matrix; and an inhibitor comprising: zinc molybdate, cerium citrate, magnesium metasilicate, a metal phosphate silicate, or a combination thereof, wherein the metal within the matrix comprises aluminum, an aluminum alloy, zinc, a zinc alloy, magnesium, a magnesium alloy, or a combination thereof. Also disclosed is a substrate coated with the corrosion inhibition coating.

EP 3 670 614 A1

## Description

BACKGROUND

**[0001]** Exemplary embodiments pertain to the art of corrosion inhibition coatings, more particularly, to chromium-free corrosion inhibition coatings for aircraft components.

**[0002]** Alloys require corrosion protection in aerospace applications. Conventional sacrificial corrosion inhibition coatings for high operating temperatures are based on aluminum-ceramic paints with hexavalent chromium compound additives as corrosion inhibitors. However, hexavalent chromium-containing compounds are considered environmental hazards by government agencies around the world. In addition, chromium-free compounds can lack sufficient corrosion inhibition properties.

**[0003]** Therefore, there is a need to develop a chromium-free corrosion inhibition coating with equal or better corrosion inhibition properties as compared to conventional hexavalent chromium-containing compounds.

BRIEF DESCRIPTION

**[0004]** Disclosed is a corrosion inhibition coating, comprising: a base comprising a matrix and a metal within the matrix; and an inhibitor. The inhibitor comprises zinc molybdate, cerium citrate, magnesium metasilicate, a metal phosphate silicate, or a combination thereof, e.g. zinc molybdate, cerium citrate, magnesium metasilicate, and/or a metal phosphate silicate. The metal within the matrix comprises aluminum, an aluminum alloy, zinc, a zinc alloy, magnesium, a magnesium alloy, or a combination thereof, e.g. aluminum, an aluminum alloy, zinc, a zinc alloy, magnesium, and/or a magnesium alloy. Also disclosed is a corrosion inhibition coating, comprising: a base comprising a matrix and a metal within the matrix; and an inhibitor comprising: zinc molybdate, cerium citrate, magnesium metasilicate, and a metal phosphate silicate, or a combination thereof, wherein the metal within the matrix comprises aluminum, an aluminum alloy, zinc, a zinc alloy, magnesium, a magnesium alloy, or a combination thereof.

**[0005]** Also disclosed is a substrate coated with the corrosion inhibition coating, e.g. as disclosed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. 1 is a cross-section of a corrosion inhibition coating comprising two distinct layers on a substrate according to an exemplary embodiment; and

FIG. 2 is a cross-section of a mixed corrosion inhibition coating on a substrate according to an exemplary embodiment.

DETAILED DESCRIPTION

**[0007]** A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

**[0008]** Referring to FIG. 1, a multilayer structure 10 includes a corrosion inhibition coating 12 coated on a substrate 18. The corrosion inhibition coating 12 can comprise an inhibitor 16 coated on a base 14. The base 14 and the inhibitor 16 can be two distinct layers as shown in FIG. 1. Referring to the multilayer structure 10 of FIG. 2, an inhibitor 16 can be mixed within a base 14 to form a corrosion inhibition coating 12 as a single layer. The corrosion inhibition coating 12 can be coated on the substrate 18.

**[0009]** The corrosion inhibition coating 12 can be a chromium-free corrosion inhibition coating, for example, a chromate-free corrosion inhibition coating, with equal or better corrosion inhibition properties as compared to conventional hexavalent chromium-containing compounds. The corrosion inhibition coating 12 can function in a wide range of applications, environments, and temperatures. The corrosion inhibition coating 12 is also environmentally friendly. The corrosion inhibition coating 12 can inhibit the corrosion of metal, thereby extending the life-time of a substrate 18.

**[0010]** As shown in FIG. 1, for example, the corrosion inhibition coating 12 can comprise a base 14 comprising a matrix and a metal within the matrix. In the coatings disclosed herein, the matrix can comprise a silicate, epoxy, ceramic, or a combination thereof, e.g. any suitable silicate, epoxy, ceramic, or a combination thereof. For example, suitable ceramics can include alumina, beryllia, ceria, zirconia, carbide, boride, nitride, and silicide. The metal within the matrix can comprise aluminum, an aluminum alloy, zinc, a zinc alloy, magnesium, a magnesium alloy, or a combination thereof.

**[0011]** The corrosion inhibition coating 12 can also comprise an inhibitor 16. For example, the inhibitor 16 can comprise zinc molybdate ($ZnMoO_4$), cerium citrate, for example, trivalent cerium citrate ($C_6H_5CeO_7$), magnesium metasilicate ($MgO_3Si$), and a metal phosphate silicate. The inhibitor 16 can be in the form of a powder.

**[0012]** The corrosion inhibition coating 12 can comprise about 1% to about 99% base 14 by volume and about 1% to about 99% inhibitor 16 by volume. For example, the corrosion inhibition coating 12 can comprise about 70% to about 95% base 14 by volume and about 5% to about 30% inhibitor 16 by volume. The corrosion inhibition coating 12 can comprise about 85% to about 95% base 14 by volume and about 5% to about 15% inhibitor 16 by volume. The corrosion inhibition coating 12 can comprise less than or equal to about 50% inhibitor 16 by volume. For example, the corrosion inhibition coating 12 can comprise less than or equal to about 10%

inhibitor 16 by volume.

**[0013]** The inhibitor 16 can comprise about 0% to about 100% (e.g. up to 100%) zinc molybdate by weight; about 0% to about 100% (e.g. up to 100%) cerium citrate, for example, trivalent cerium citrate by weight; about 0% to about 100% (e.g. up to 100%) magnesium metasilicate by weight; and about 0% to about 100% (e.g. up to 100%) of a metal phosphate silicate by weight. For example, the inhibitor 16 can comprise about 1% to about 50% zinc molybdate by weight; about 1% to about 50% cerium citrate, for example, trivalent cerium citrate, by weight; about 1% to about 50% magnesium metasilicate by weight; and about 1% to about 50% of a metal phosphate silicate by weight. For example, the inhibitor 16 can comprise about 25% zinc molybdate by weight; about 25% cerium citrate by weight; about 25% magnesium metasilicate by weight; and about 25% of a metal phosphate silicate by weight.

**[0014]** The inhibitor 16 can comprise about 1/3 zinc molybdate by weight; about 1/3 magnesium metasilicate by weight; and about 1/3 of a metal phosphate silicate by weight. The inhibitor 16 can comprise about 50% zinc molybdate by weight; and about 50% cerium citrate, for example, trivalent cerium citrate, by weight. The inhibitor 16 can also consist of only four components, namely, the zinc molybdate, the cerium citrate, the magnesium metasilicate, and the metal phosphate silicate. For example, the corrosion inhibition coating 12 can comprise 0% magnesium molybdate. The corrosion inhibition coating 12 can also comprise 0% chromium.

**[0015]** The metal phosphate silicate of the inhibitor 16 can comprise aluminum phosphate silicate, zinc phosphate silicate, calcium phosphate silicate, strontium phosphate silicate, or a combination thereof.

**[0016]** The inhibitor 16 can be mixed within the base 14, for example so as to form a single layer 12 as shown in FIG. 2. For example, the matrix of the base 14 can serve as the matrix for the inhibitor 16. The base 14 and the inhibitor 16 can also be unmixed, for example so as to form two distinct layers as shown in FIG. 1. In the case where the base 14 and the inhibitor 16 form two distinct layers, the inhibitor 16 can be coated on the base 14 and is thus further from the substrate 18 than the base 14.

**[0017]** In the case where the base 14 and the inhibitor 16 form two distinct layers, the inhibitor 16 can further comprise a second matrix. For example, the inhibitor 16 can comprise about 0% to about 50% zinc molybdate by volume; about 0% to about 50% cerium citrate, for example, trivalent cerium citrate by volume; about 0% to about 50% magnesium metasilicate by volume; and about 0% to about 50% of a metal phosphate silicate by volume, mixed within the second matrix. For example, the second matrix can be greater than or equal to about 50% by volume of the inhibitor 16. For example, the second matrix can comprise silicate, epoxy, ceramic, or a combination thereof.

**[0018]** The curing temperature of the corrosion inhibition coating 12 will vary depending on the particular matrix used. For example, curing temperatures can be different for silicate, epoxy, and ceramic matrices. Curing duration can also vary with curing temperature. For example, if a higher curing temperature is used, less curing time is required.

**[0019]** In the case where the inhibitor 16 is mixed within the base 14 so as to form a single layer, the corrosion inhibition coating 12 can be cured at a single temperature, corresponding to the matrix used. In the case where the base 14 and the inhibitor 16 form two distinct layers, two different curing temperatures can be used, corresponding to the matrix used for each layer. For example, the base 14 can be cured at a first temperature, followed by addition of the inhibitor 16 and curing at a second temperature. For example, curing temperatures can be about 20°C to about 200°C.

**[0020]** The corrosion inhibition coating 12 can be coated onto a substrate 18. For example, the substrate 18 can comprise steel, aluminum, zinc, magnesium, or a combination thereof. For example, the substrate 18 can comprise alloys of these metals. The corrosion inhibition coating 12 can function in a wide range of applications and environmental temperatures. For example, the substrate 18 can be an aircraft component. For example, the aircraft component can be a propeller blade, a propeller shank, a propeller hub, a propeller barrel, a propeller tulip, a landing gear component, an engine gear, an engine disc, a shaft, for example, an engine shaft, a strut, or a counterweight.

**[0021]** Set forth below are some embodiments of the foregoing disclosure:

Embodiment 1. A corrosion inhibition coating, comprising: a base comprising a matrix and a metal within the matrix; and an inhibitor. The inhibitor comprising: zinc molybdate, cerium citrate, magnesium metasilicate, a metal phosphate silicate, or a combination thereof, e.g. zinc molybdate, cerium citrate, magnesium metasilicate, and a metal phosphate silicate, or a combination thereof. The metal within the matrix comprises aluminum, an aluminum alloy, zinc, a zinc alloy, magnesium, a magnesium alloy, or a combination thereof.

Embodiment 2. The corrosion inhibition coating of Embodiment 1, wherein the matrix comprises silicate, epoxy, ceramic, or a combination thereof.

Embodiment 3. The corrosion inhibition coating of Embodiment 1 or 2, wherein the corrosion inhibition coating comprises: about 70% to about 95% base by volume; and about 5% to about 30% inhibitor by volume.

Embodiment 4. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the corrosion inhibition coating comprises less than or equal to about 10% inhibitor by volume.

Embodiment 5. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the inhibitor consists of: zinc molybdate; cerium citrate; magnesium metasilicate; and a metal phosphate silicate.

Embodiment 6. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the inhibitor comprises: about 25% zinc molybdate by weight; about 25% cerium citrate by weight; about 25% magnesium metasilicate by weight; and about 25% of a metal phosphate silicate by weight.

Embodiment 7. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the inhibitor comprises: about 1% to about 50% zinc molybdate by weight; about 1% to about 50% cerium citrate by weight; about 1% to about 50% magnesium metasilicate by weight; and about 1% to about 50% of a metal phosphate silicate by weight.

Embodiment 8. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the corrosion inhibition coating comprises 0% chromium.

Embodiment 9. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the corrosion inhibition coating comprises 0% magnesium molybdate.

Embodiment 10. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the metal phosphate silicate comprises aluminum phosphate silicate, zinc phosphate silicate, calcium phosphate silicate, strontium phosphate silicate, or a combination thereof.

Embodiment 11. The corrosion inhibition coating of any one of the preceding Embodiments, wherein the inhibitor is a powder.

Embodiment 12. The corrosion inhibition coating of any one of Embodiments 1 to 11, wherein the inhibitor is mixed within the base.

Embodiment 13. The corrosion inhibition coating of any one of Embodiments 1 to 11, wherein the base and the inhibitor are two distinct layers.

Embodiment 14.The corrosion inhibition coating of Embodiment 13, wherein the inhibitor is coated on the base.

Embodiment 15. The corrosion inhibition coating of Embodiment 13 or Embodiment 14, further comprising a second matrix, wherein the inhibitor is mixed within the second matrix.

Embodiment 16. The corrosion inhibition coating of Embodiment 15, wherein the second matrix comprises silicate, epoxy, ceramic, or a combination thereof.

Embodiment 17. A substrate coated with the corrosion inhibition coating of any one of the preceding Embodiments.

Embodiment 18. The substrate of Embodiment 17, wherein the substrate comprises steel, aluminum, zinc, magnesium, or a combination thereof.

Embodiment 19. The substrate of Embodiment 17 or Embodiment 18, wherein the substrate is an aircraft component.

Embodiment 20. The substrate of Embodiment 19, wherein the aircraft component is a propeller blade, a propeller shank, a propeller hub, a propeller barrel, a propeller tulip, a landing gear component, an engine gear, an engine disc, a shaft, a strut, or a counterweight.

**[0022]** The term "about" is intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application.

**[0023]** The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components (and encompasses "consist(s) of', "consisting of', "consist(s) essentially of" and "consisting essentially of'), but do not necessarily preclude the presence or addition of one or more other features, integers, steps, operations, element components, and/or groups thereof.

**[0024]** While the present disclosure has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this present disclosure, but that the present disclosure will include all embodiments falling within the scope of the claims.

**Claims**

1. A corrosion inhibition coating, comprising:

    a base comprising a matrix and a metal within the matrix; and
    an inhibitor comprising:

        zinc molybdate,
        cerium citrate,
        magnesium metasilicate,
        a metal phosphate silicate, or a combination thereof,

    wherein the metal within the matrix comprises aluminum, an aluminum alloy, zinc, a zinc alloy, magnesium, a magnesium alloy, or a combination thereof.

2. The corrosion inhibition coating of Claim 1, wherein the matrix comprises silicate, epoxy, ceramic, or a combination thereof.

3. The corrosion inhibition coating of Claim 1 or Claim 2, wherein the corrosion inhibition coating comprises:

    about 70% to about 95% base by volume; and
    about 5% to about 30% inhibitor by volume.

4. The corrosion inhibition coating of any one of the preceding Claims, wherein the corrosion inhibition coating comprises less than or equal to about 10% inhibitor by volume.

5. The corrosion inhibition coating of any one of the preceding Claims, wherein the inhibitor consists of:

    zinc molybdate;
    cerium citrate;
    magnesium metasilicate; and
    a metal phosphate silicate.

6. The corrosion inhibition coating of any one of the preceding Claims, wherein the inhibitor comprises:

    about 25% zinc molybdate by weight;
    about 25% cerium citrate by weight;
    about 25% magnesium metasilicate by weight; and
    about 25% of a metal phosphate silicate by weight.

7. The corrosion inhibition coating of any one of the preceding Claims, wherein the inhibitor comprises:

    about 1% to about 50% zinc molybdate by weight;
    about 1% to about 50% cerium citrate by weight;
    about 1% to about 50% magnesium metasilicate by weight; and
    about 1% to about 50% of a metal phosphate silicate by weight.

8. The corrosion inhibition coating of any one of the preceding Claims, wherein the corrosion inhibition coating comprises 0% chromium, and/or
wherein the corrosion inhibition coating comprises 0% magnesium molybdate.

9. The corrosion inhibition coating of any one of the preceding Claims, wherein the metal phosphate silicate comprises aluminum phosphate silicate, zinc phosphate silicate, calcium phosphate silicate, strontium phosphate silicate, or a combination thereof, and/or
wherein the inhibitor is a powder.

10. The corrosion inhibition coating of any one of Claims 1 to 9,
wherein the inhibitor is mixed within the base, or
wherein the base and the inhibitor are two distinct layers.

11. The corrosion inhibition coating of any preceding Claim, wherein the inhibitor is coated on the base.

12. The corrosion inhibition coating of any preceding claim, further comprising a second matrix, wherein the inhibitor is mixed within the second matrix, preferably wherein the second matrix comprises silicate, epoxy, ceramic, or a combination thereof.

13. A substrate coated with the corrosion inhibition coating of any one of the preceding claims.

14. The substrate of Claim 13, wherein the substrate comprises steel, aluminum, zinc, magnesium, or a combination thereof.

15. The substrate of Claim 13 or claim 14, wherein the substrate is an aircraft component, preferably wherein the aircraft component is a propeller blade, a propeller shank, a propeller hub, a propeller barrel, a propeller tulip, a landing gear component, an engine gear, an engine disc, a shaft, a strut, or a counterweight.

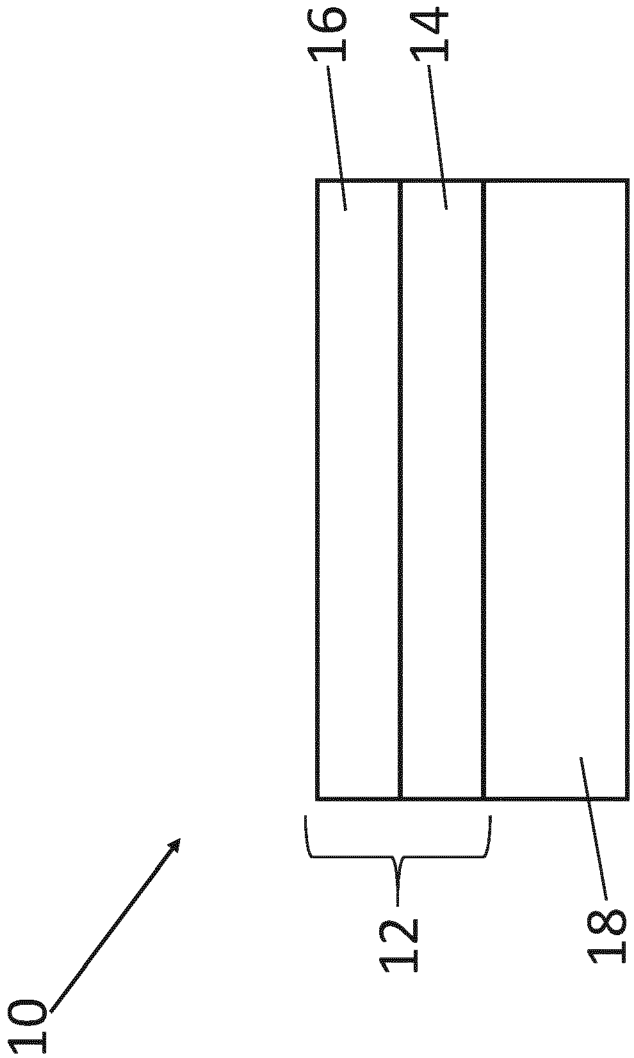


FIG. 1

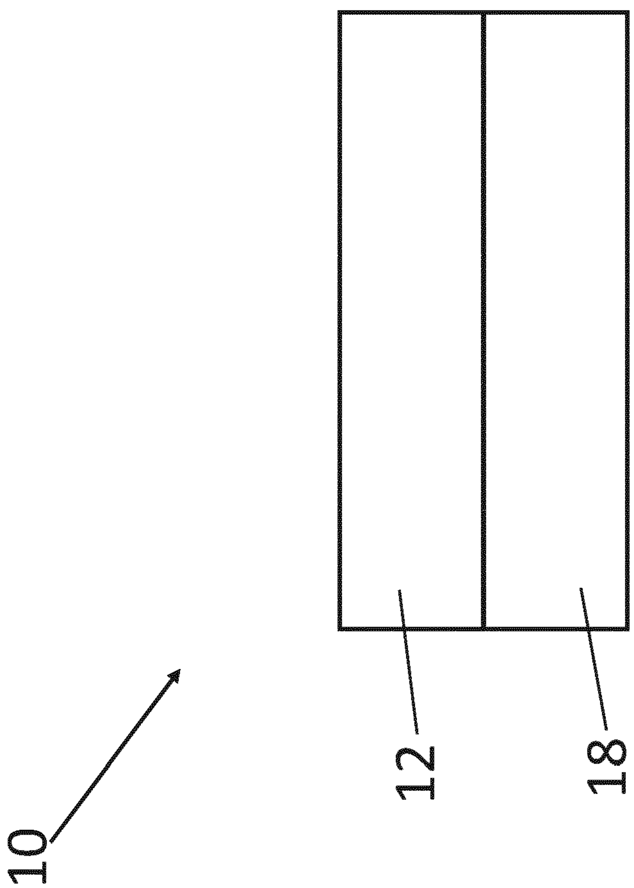


FIG. 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

# EUROPEAN SEARCH REPORT

Application Number
EP 19 21 4574

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | US 2010/197836 A1 (PRICE CRAIG [US] ET AL) 5 August 2010 (2010-08-05)<br>* the whole document *<br>* paragraph [0028] - paragraph [0029]; claim 31 *<br>* paragraph [0033] *<br>* paragraph [0039] *<br>----- | 1-15 | INV.<br>C09D5/08<br>C09D5/10<br>C09D7/61<br>C09D163/00<br>C09D1/02<br><br>ADD.<br>C08K3/08<br>C08K3/22<br>C08K3/32<br>C08K3/34<br>C08K5/098 |
| X | EP 1 975 207 A1 (DACRAL [FR]) 1 October 2008 (2008-10-01)<br>* the whole document *<br>* paragraph [0027] - paragraph [0031]; table 1 *<br>* paragraph [0029] *<br>* paragraph [0037] *<br>----- | 1-4, 8-10, 12-14 | |
| X | CN 107 216 697 A (UNIV CHINA MINING) 29 September 2017 (2017-09-29)<br>* the whole document *<br>* paragraph [0062] - paragraph [0063]; example 1 *<br>* paragraph [0002] *<br>----- | 1-4, 8-10, 12-14 | TECHNICAL FIELDS SEARCHED (IPC)<br>C09D<br>C09J<br>C09G |
| A | CN 101 481 510 A (ZHONG DING [CN]) 15 July 2009 (2009-07-15)<br>* the whole document *<br>* claim 7 *<br>----- | 1-15 | |
| A,P | US 2019/127860 A1 (DING ZHONGFEN [US] ET AL) 2 May 2019 (2019-05-02)<br>* the whole document *<br>* claim 7 *<br>----- | 1-15 | |
| A | EP 2 924 078 A1 (GOODRICH CORP [US]) 30 September 2015 (2015-09-30)<br>* the whole document *<br>----- | 1-15 | |

The present search report has been drawn up for all claims

1

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 29 April 2020 | Rangheard, Claudine |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 21 4574

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-04-2020

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2010197836 A1 | 05-08-2010 | NONE | |
| EP 1975207 A1 | 01-10-2008 | AR 031326 A1 | 17-09-2003 |
| | | AR 060200 A2 | 04-06-2008 |
| | | AR 062912 A2 | 17-12-2008 |
| | | AT 400619 T | 15-07-2008 |
| | | AT 494338 T | 15-01-2011 |
| | | AU 2524902 A | 21-05-2002 |
| | | BG 107791 A | 30-11-2004 |
| | | BR 0115338 A | 26-08-2003 |
| | | CA 2427807 A1 | 16-05-2002 |
| | | CN 1633478 A | 29-06-2005 |
| | | CZ 20031328 A3 | 12-05-2004 |
| | | DE 08101487 T1 | 16-04-2009 |
| | | EE 200300185 A | 15-08-2003 |
| | | EP 1334158 A2 | 13-08-2003 |
| | | EP 1975207 A1 | 01-10-2008 |
| | | ES 2309110 T3 | 16-12-2008 |
| | | ES 2332865 T1 | 15-02-2010 |
| | | FR 2816641 A1 | 17-05-2002 |
| | | HK 1078603 A1 | 20-07-2007 |
| | | HK 1122326 A1 | 22-07-2011 |
| | | HU 0400601 A2 | 28-06-2004 |
| | | JP 4193493 B2 | 10-12-2008 |
| | | JP 2004514013 A | 13-05-2004 |
| | | JP 2008280538 A | 20-11-2008 |
| | | KR 20030045189 A | 09-06-2003 |
| | | MX PA03004207 A | 02-12-2004 |
| | | MY 140559 A | 31-12-2009 |
| | | PL 212402 B1 | 28-09-2012 |
| | | PL 361004 A1 | 20-09-2004 |
| | | PT 1334158 E | 24-09-2008 |
| | | RU 2279455 C2 | 10-07-2006 |
| | | SI 1334158 T1 | 31-10-2008 |
| | | SK 5742003 A3 | 04-11-2003 |
| | | TW 588100 B | 21-05-2004 |
| | | US 2004142162 A1 | 22-07-2004 |
| | | US 2006112849 A1 | 01-06-2006 |
| | | US 2006188731 A1 | 24-08-2006 |
| | | WO 0238686 A2 | 16-05-2002 |
| | | ZA 200303539 B | 13-11-2003 |
| CN 107216697 A | 29-09-2017 | NONE | |
| CN 101481510 A | 15-07-2009 | NONE | |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 21 4574

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-04-2020

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2019127860 A1 | 02-05-2019 | NONE | |
| EP 2924078 A1 | 30-09-2015 | BR 102015006814 A2 | 24-05-2016 |
| | | CA 2883544 A1 | 28-09-2015 |
| | | EP 2924078 A1 | 30-09-2015 |
| | | JP 6499893 B2 | 10-04-2019 |
| | | JP 2015190060 A | 02-11-2015 |
| | | KR 20150112867 A | 07-10-2015 |
| | | US 2015274984 A1 | 01-10-2015 |
| | | US 2016115325 A1 | 28-04-2016 |
| | | US 2016137851 A1 | 19-05-2016 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82